I/ITSEC 2000 Panel on Economics of Modeling & Simulation

“M&S Business and SBA at Boeing”

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M&S Business Case Today at Boeing

- **M&S is integral part of Engineering & Manufacturing Process**
- **M&S is used as competitive discriminant and is a core competency**
- **Focused to make it broad based, standardized, efficient, and cost effective**
- **Already doing much of SBA Enablers**

DRAFT

Core Competencies; Boeing Vision 2016

- ***Detailed Customer Knowledge & Focus***
  - _____
  - _____
  - _____
- ***Large Scale System Integration***
  - _____
  - _____
  - _____
  - _____
- ***Lean Efficient Design and Production System***
  - _____
  - _____
  - **Modeling & Simulation/Simulation Based Acquisition**
  - _____

ISG's SBA Enablers

- ✓ Policy, process and organizational changes
- ✓ Models, simulations and other tools
- ✓ Standards and means for information exchange
- ✓ Ensuring authoritative representation
- ✓ Managing collaboration and multi-domain optimization
- ✓ Means to identify, obtain and yet protect reusable resources
- ✓ Education and motivation
- Business case
  - ✓*SBA M&S economic issues*

Policy, Process and Organizational Changes

- Integrated many disparate tools activities into common Phantom Works Thrust
  - Lean & Efficient Design Tools & Processes
    - ✓ Charter for common tools & process for product concept development, design, & manufacturing
    - ✓ Spending 25% of PW investment dollars
    - Focal for NASA ISE Initiative
- Established a M&S Thrust
- Organizing contracted programs with strong and elevated Modeling & Simulation IPT's that look across the program, e.g., UCAV, FCS, JSF
- Writing M&S and SBA plans for the new programs, e.g., JSF, NMD, FCS
- Modeling & Simulation organization in PW

Models, Simulations, and Other Tools

- ✓ **Extensive and wide spread use of models and simulations in all disciplines, i.e., several hundreds of models**

- ✓ **Extensive investment in tools and tool infrastructure for automation of design and manufacturing, i.e., CAD CAM**
  - **CATIA**
  - **ENOVIA**

Standards and Means for Information Exchange

- ✓ Broad use of singular COTS products
- ✓ Heavy participation in STEP protocol development (data exchange for CAD CAM data)
- ✓ Heavy use of DIS, now HLA, for simulation data exchange
- ✓ Singling up on common home grown models across the company
  - ✓ Sharing with customers
  - ✓ Transferring ownership to government

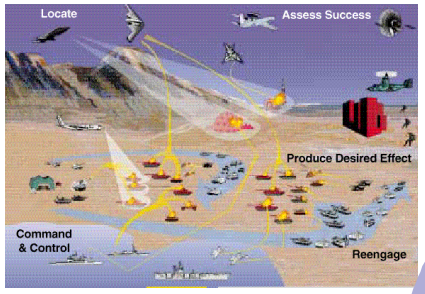
Ensuring Authoritative Representation

- ✓ Adopting and applying DMSO V,V,&A Recommended Best Practices Guide
  - ✓ Documentation of V,V,&A database
- Goal to get M&S development organizations up the SEI CMM levels
- ✓ Reducing size of model repository to best in class
  - 50% reduction in number of tools/models
- ✓ Wider spread of model use
- ✓ Strong integration of test, manufactured prototypes, etc. back into models on new programs, e.g., JSF

Managing Collaboration and Multi-Domain Optimization

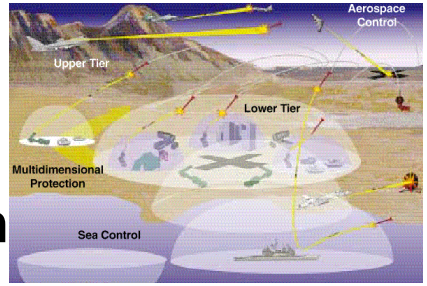
- Use of JSF Full-Mission Simulation (Pilot-in-the-Loop) for requirements, engineering & training
- ✓ Investing in distributed real-time and constructive simulation
  - Theater Sim project
- ✓ Investing in Systems of Systems evaluation facility, Boeing Integration Center
  - Modeling & Simulation
  - Information & Communication Systems
  - Product Development and Testing
  - Systems Integration
  - Focus on C2 and Battle Management for Systems of Systems

Theater Simulation Concept



Engagement, Theater & Force Structure Models

- Value of C4ISR, Battle Mgm
- Benefits of New Systems - UCAV, etc.



HLA

- Detailed System Performance
- CONOPS, Joint Ops

Virtual Simulation and HWIL Facilities

HLA

Theater Simulation

Objective

- Design, develop and implement an enduring enterprise-wide theater simulation capability
- Focus on developing an affordable, available, and responsive capability; leveraging existing Boeing assets; and aligning with future government efforts in virtual, constructive, and distributed simulation
- Utilize common processes and interface standards
- Support both a simulation development environment and evaluation/analysis of new systems with variable fidelity representations, superior visualization/data presentation, and operator-in-the-loop/hardware-in-the-loop capability

Technical Approach

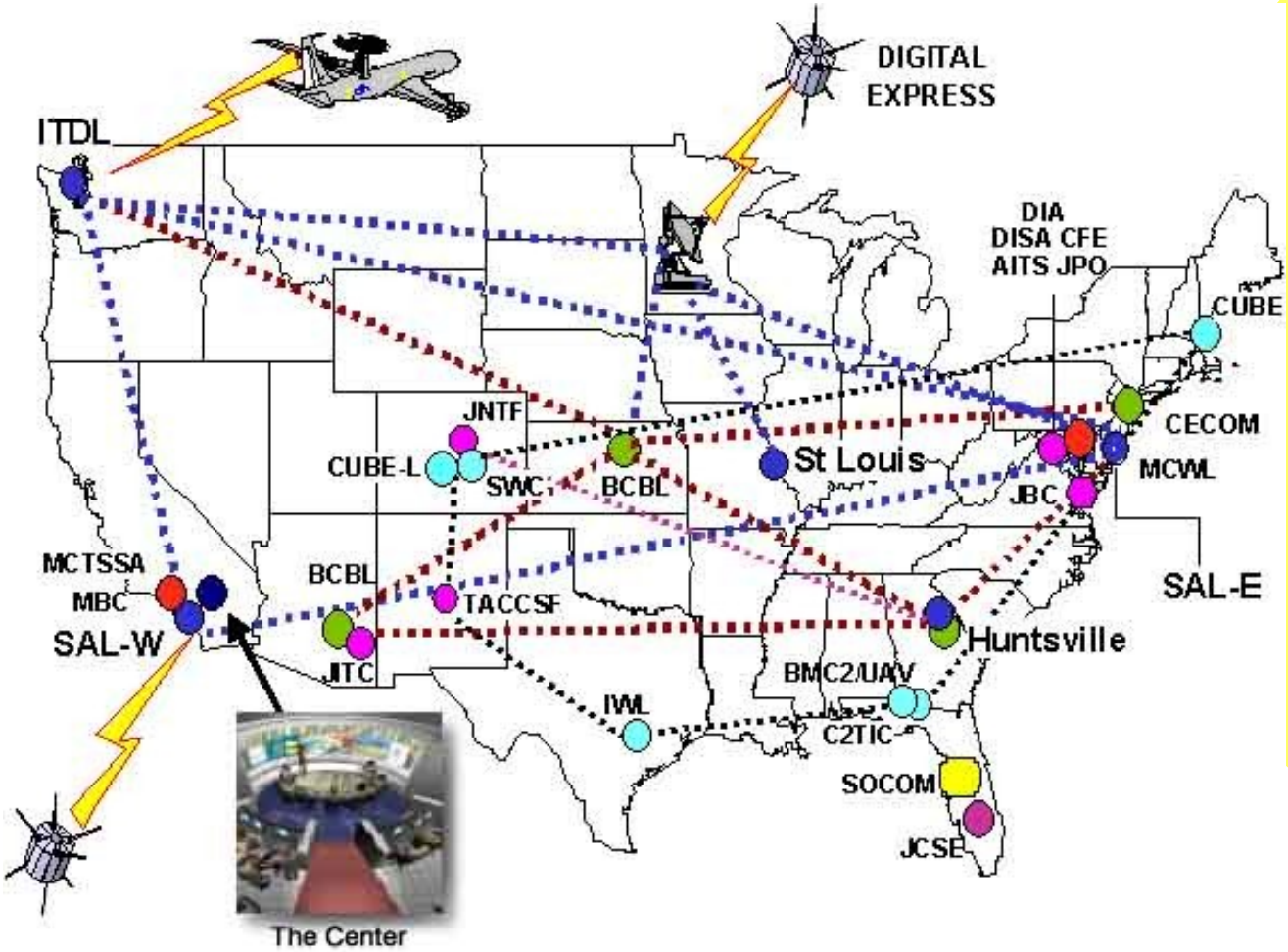
- Leverage existing assets, distributed across the enterprise, grow to include HWIL
- Build network of virtual simulations using standardized interfaces/protocols - focus on CMD
- Build federation of constructive models selected from best available - focus on space control issues
- Align with government model selection

Deliverables	Schedule				
	Q1-00	Q2-00	Q3-00	Q4-00	2001+
Development Plan	SELECT	PLANS		5-YR	
Virtual Network			ICD R	TEST	COMBINE
Constructive Federation			ICD R	TEST	

Boeing Integration Center

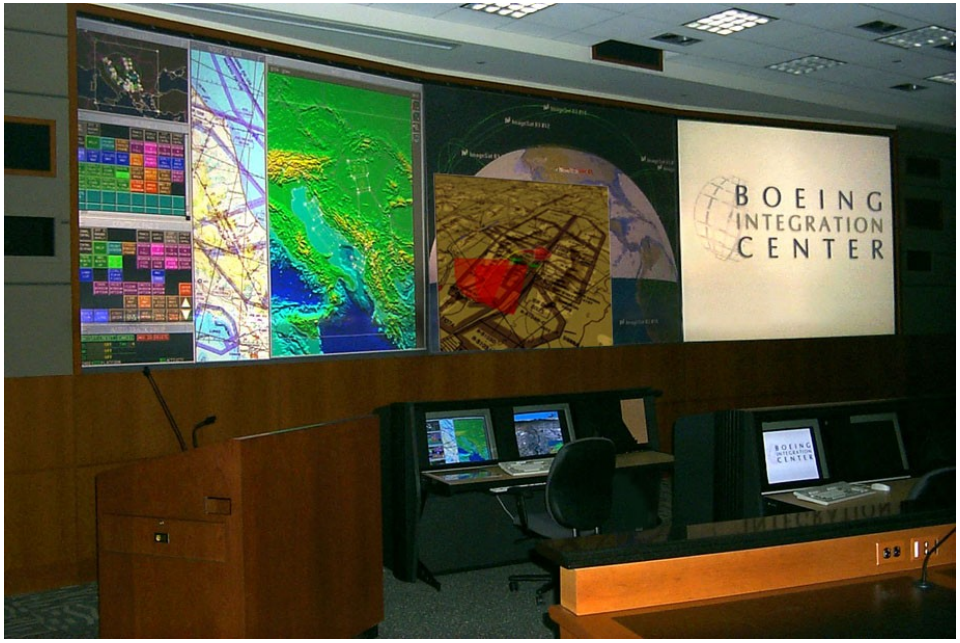
- 11,000 square foot facility located in Anaheim, CA
  - Configured as multiple secure facilities, within a secure perimeter
  - State-of-the-art 3 screen theater
- World-wide Connectivity and Bandwidth on Demand
  - 1Gb internal fiber-optic Ethernet
  - All major communications protocols supported (ATM, Ethernet, Internet, VOIP)
  - 8 dedicated point-to-point T1 connection ports
- Tools for
  - Stimulation
  - Plug-n-Play Integration/Interfacing
  - Visualization

The BIC Network Harnesses SoS Capabilities



- Anaheim (BIC)
  - Battle Mgmt/H-I-L C2
  - Info Architectures
  - Comm'l Networks
- Seattle ITDL (JSF, F-22, AWACS, etc.)
- St. Louis VWC (UCAV F-15, F-18, etc.)
- Seal Beach SAL-W
  - Launch Systems
  - Satellite Systems
- Huntsville SIL
  - NMD / TAMD
- DoD Battle Labs
- Customers / Users
- International Partners
- Suppliers & Vendors

Systems of Systems Proving Ground Ready



Means to Identify, Obtain, and Protect Reusable Resources

- ✓ Extensive use of government models in concept phase of life cycle
  - ✓ Strong support for Services to single up on mission environment models
    - JIMM for SWEG/SUPPRESSOR
    - JIMM integrated with DIADS
  - ✓ Strong support for expansion into HLA Federations
- ✓ Make available to government and industry Boeing developed models
  - ✓ MIL-AASPEM
  - ✓ AMASIM
- ✓ Strong emphasis on re-use of models and simulations through entire life cycle
  - NMD Test, Training, & Evaluation Capability (TTEC)

Business Case

- Use of modeling & simulation is going to increase on DoD & NASA programs independent of any SBA initiative
  - Cheaper than prototypes
  - Complexity of products
  - Systems of systems interactions/dependencies/netcentric warfare
  - Computing capability cheaper and more capable

- Boeing looked on as a industry leader in modeling and simulation, i.e., 777, JSF, NMD
  - Trying to exploit modeling & simulation as a discriminant ✓
  - Heavily funding streamlined, computer based, product life cycle process and tools ✓

✓ **The Business Case for SBA today is the Business Case for expanding use of models, simulations, and tools inside**

Summary M&S Economic Issues in SBA Paradigm

- SBA has possibility to drive towards more of a commercial investment business model for DoD
  - How much M&S investment will be required to market users?
  - How to incentivize industry to invest more to reduce product recurring cost so as to sell more units?
- SBA calls for open sharing and re-use of models, tools, etc. across industries and DoD programs
  - What can be the economic mechanisms to encourage this behavior?
  - Who provides reusable models to established DoD programs?
  - Who maintains models, etc.?
  - How to accomplish across all DoD programs when we have independent Service procurement authority today?

Summary

- Boeing making significant M&S investments across the entire life cycle
- Models and data essentially capture majority of corporate product knowledge
- Boeing want to leverage those investments to increase business in our product lines
- Major current issues
  - How to invest wisely and efficiently in M&S with limited investment dollars and large sunk costs in 3 different companies
  - How to best organize and utilize M&S professionals

One Last Thought on Economics of M&S

- **Read "Serious Play – How the World's Best Companies Simulate to Innovate" by Michael Schrage**

- **His 10 Rules of Good Use of M&S**
  1. **Figure out who stands to benefit from model results**
  2. **Decide metrics output of model and measure rigorously**
  3. **Fail early and often using cheap models in the design process**
  4. **Manage diverse modeling approaches/mediums**
  5. **Have a migration path of the models to the product**
  6. **Use models as a means for innovation & creativity by bosses, clients, and supplier**
  7. **Create markets around the models to help subsidize the process of innovation**
  8. **Encourage role playing using the model/simulation**
  9. **Determine the points of diminishing returns**
  10. **Record and review the process relentlessly and vigorously**